The § 112 rejections

Claims 19-25, 35-37 stand rejected under 35 U.S.C. § 112. The Examiner lists several concerns.

Claims 19 has been amended to change "an exterior of the reaction chamber is substantially free of a magnetic field during the heating" to --by a burner or a heating chamber in which a heated fluid flows--. This limitation with regard to the heating chamber is supported by the description starting page 11, line 13 through page 12, line 9, and this limitation with regard to the burner is supported by the description at page 17, lines 31 through page 18, line 5. Therefore, it is respectfully submitted that no new matter has been added.

Claims 22 and 27 have been amended to insert the units for velocity and distance, which were mistakenly deleted in the previous response. Therefore, it is respectfully submitted that claims 22 and 27 are definite.

Claim 26 has been amended to make it consistent with claims 35 and 36.

Claim 37 has been amended to change "that generates substantially no magnetite field around the reaction chamber" to --including a burner and a heating chamber, which is surrounding the reaction chamber and in which a heated fluid flows--. This limitation is supported by the above mentioned description for claim 19. Therefore, it is respectfully submitted that no new matter has been added.

Accordingly, it is respectfully submitted that all claims now fully comply with 35 U.S.C. § 112. Therefore, it is respectfully requested that the rejection be withdrawn.

The § 103 rejections

Claims 19-22 and 25-34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over UK Patent Application No. 2,244,230.

Claims 19 and 37 are directed to a method for manufacturing carbon fiber coils. The method includes heating a reaction chamber by a burner (28) or a heating chamber (29) in which a heated fluid flows. Claim 26 is directed to an apparatus for manufacturing carbon fiber coils. The apparatus includes a heating device for heating a

reaction chamber. The heating device is a burner (28) or a heating chamber (24) in which a heated fluid flows.

According to the method and the apparatus of the present invention, since no magnetic field is generated when the burner or the heating chamber heats the reaction chamber, carbon coils that have a circular cross section are produced.

The carbon coils elastically extend to about five times their original length, and the tensile strength of the carbon fiber coils was 120 to 150 kg/mm^2 (see Example 1, particularly, page 21, lines 7-13 in the specification). Therefore, relatively strong and elastic carbon fibers are produced by the present invention.

The cited reference (UK Patent Application No. 2,248,230) teaches making carbon fibers from hydrocarbon gas and catalyst. However, the cited reference teaches heating a reaction chamber with an electric furnace, which have metal coils. Such metal coils create a magnetic field in the reaction chamber. The cited reference did not consider influences of an electromagnetic field generated by the electric furnace on the shape of carbon coils. On page 21, line 15 through page 22, line 15 of the present specification, Comparative Example 1 is described, which corresponds to the method and the apparatus of the cited reference. According to the Comparative Example 1, the carbon fiber coils that have an oblate cross section are produced. The carbon coils break when they were elongated to about three times their original length, and the tensile strength of the carbon fiber coils was 45 to 60 kg/mm^2. Therefore, the carbon coils are weaker and less elastic than that of the present invention.

The growing mechanism for a carbon coil is as follows. When stock gas, such as hydrocarbon gas, a catalytic gas, such as H_2S, and a balance gas, such as hydrogen gas, are supplied to a solid catalyst (nickel particle), the solid catalyst temporally absorbs the gases. The gases are thermal decomposed on the inside and at the surface of the solid catalyst. The decomposition produces carbons, and carbon fibers grow starting at the surface of the solid catalyst.

More particularly, when the solid catalyst absorbs the gases, Nickel carbide is formed inside the catalyst, and elements of Ni, C, O and S form a pseudo-liquid phase

mixture at the surface of the catalyst. Nickel carbide is rigid and is not susceptible to the electromagnetic field, but the pseudo-liquid phase mixture is soft and is susceptible to an electromagnetic field. When the catalyst is exposed to the electromagnetic field, the pseudo-liquid phase mixture deforms to an elongate shape due to the electromagnetic field. As the result, carbon fibers having an oblate cross section are produced, since carbon fiber grows from the elongated catalyst. On the other hand, when the catalyst is under a weaker electromagnetic field, the pseudo-liquid mixture hardly deforms. In this case, carbon coils having a circular cross section is produced.

In the cited reference, the reaction chamber is heated by an electric furnace, which generates a relatively strong electromagnetic field, and thereby the catalyst deforms. As a result, carbon fiber having an oblate cross section is produced.

On the other hand, with the present invention as recited in the claims, the reaction chamber is heated by a burner or a heating chamber, which generates no electromagnetic field, and thereby the catalyst hardly deforms. As a result, carbon fibers having a circular cross section are produced.

Accordingly, it is respectfully submitted that claims 19, 26 and 37 are allowable.

Claims 20-25 depend on claim 19, claims 27-32 depend on claim 26, and claims 36-37 depend on claim 35. Accordingly, these claims are allowable for at least the reasons claims 19, 26 and 37 are allowable. These claims further define and augment the features of Applicants' invention.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Please amend clams 19, 22, 26, 27, and 37 and cancel claims 33 and 34 as follows:

19. (Twice Amended) A method of[,] manufacturing carbon fiber coils comprising:

placing a solid catalyst [at] within a reaction chamber;

supplying stock gas and a catalytic gas to the reaction chamber;

heating [the interior of] the reaction chamber to grow carbon fiber coils from the stock gas [,wherein an exterior of the reaction chamber is substantially free of a magnetic field during the heating] by a burner or a heating chamber in which a heated fluid flows.

22. (Twice Amended) The method of claim 21 including setting the position of the solid catalyst and the velocity of the stock gas, wherein the ratio of the velocity of the stock gas to a distance between an outlet of the port and the solid catalyst is set in a range of 10 to 10000, wherein the velocity is expressed in centimeters per minute and the distance is expressed in centimeters.

26. (Twice Amended) An apparatus for manufacturing carbon fiber coils from a stock gas, which is subjected to thermal decomposition to generate solid carbon, and a catalytic gas, which promotes thermal decomposition of the stock gas, the apparatus comprising:

a reaction chamber, to which the stock gas and the catalytic gas are supplied through a port;

a solid catalyst located within the reaction chamber; and

a heating device for heating [the interior of] the reaction chamber to grow carbon fiber coils from the stock gas, wherein the heating device [produces substantially no magnetic field in the reaction chamber] is a burner or a healing chamber, which is surrounding the reaction chamber and in which a heated fluid flows.

27. (Twice Amended) The apparatus according to claim 26, wherein the solid catalyst faces an outlet of the port and is spaced from the outlet by a distance, and the stock gas is supplied to the reaction chamber at a certain velocity, wherein the ratio of the velocity of the stock gas to the distance is in a range of 10 to 10000, wherein the velocity is expressed in centimeters per minute and the distance is expressed in centimeters.

33. (Cancelled)

34. (Cancelled)

37. (Amended) A method of manufacturing carbon fiber coils comprising:

placing a solid catalyst within a reaction chamber, wherein the solid catalyst is spaced apart from an outlet of a gas supplying port of the reaction chamber at a predetermined distance;

supplying a stock gas and a catalytic gas to the reaction chamber, wherein the stock gas is supplied through the gas supplying port at a predetermined velocity, wherein the ratio of the velocity to the distance is set in a range of 10 to 10000, wherein the velocity is expressed in centimeters per minute and the distance is expressed in centimeters;

applying a DC voltage to the solid catalyst to negatively charge the solid catalyst; and heating the reaction chamber to a temperature in a range of 700 to 830 degrees Centigrade to grow carbon fiber coils from the stock gas using a heating device [that generates substantially no magnetic field around the reaction chamber] including a burner and a heating chamber, which is surrounding tree reaction chamber and in which a heated fluid flows.